DMRG Studies for Itinerant Ferromagnetism in a Two-leg Optical Lattice System(New Development of Numerical Simulations in Low-Dimensional Quantum Systems: From Density Matrix Renormalization Group to Tensor Network Formulations)

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Density matrix renormalization group (DMRG) is one of the most powerful methods for investigating strongly correlated systems. Recently, three of the present authors have developed a parallel DMRG code [1] that enables us to calculate the ground state of n-leg lattice models efficiently. We can thus explore multi-leg ladder systems to look for intriguing physics that is speci c to ladder structures, e.g., ferromagnetism in the Hubbard model.

It has been well-known that the lattice structure in addition to strong on-site repulsion is responsible for non-trivial ground state. A typical example is the itinerant ferromagnetism, which still de es full understanding. Besides electron systems, cold Fermionic atom systems is an ideal test-bench for such studies due to its flexibility and controllability on lattice structures. In fact, three itinerant ferromagnetism, i.e., Stoner's, Nagaoka's, and flat-band mechanisms have been so far discussed in ultra-cold atom experiments, and the rst one has been reported very recently [2].

With this background, here we propose that a two-leg ladder optical lattice system should accommodate a stable itinerant ferromagnetism for cold fermionic atoms with nite hole densities [3], which may be regarded as an extended Nagaoka's ferromagnetism. A special interest in the cold atom system is that, on top of the optical lattice potential, we have a trapping potential. We predict that this causes an interesting phase separation into magnetic and nonmagnetic phases in real space. We show the phase-separated magnetism speci cally in spin-imbalanced situations, and the phase diagram obtained here indicates that the required strength of correlation is realistic.

References

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